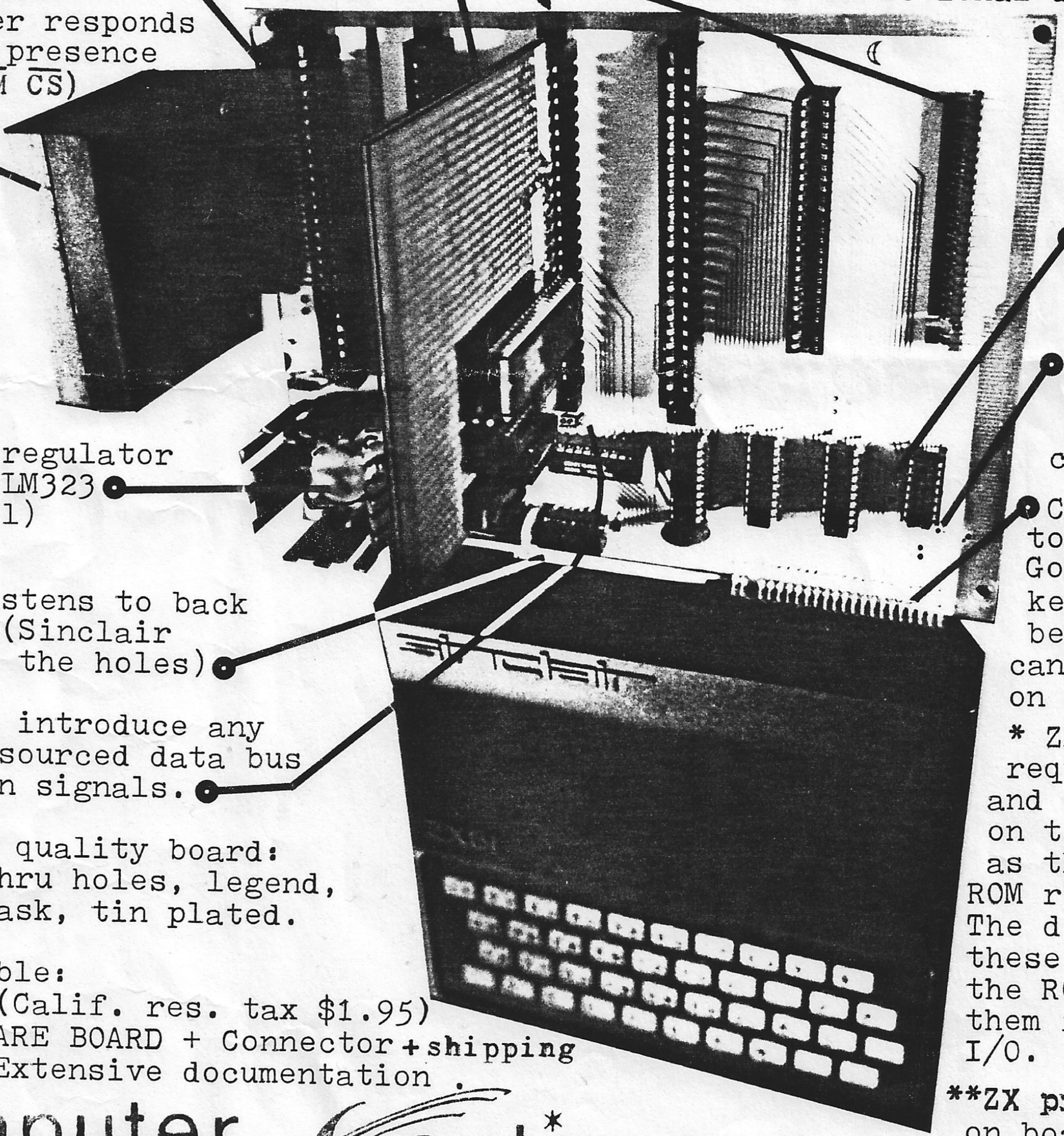
3/11/82

EXPANSION BOARD FOR SINCLAIR COMPUTERS: ZX80*/81/MicroAce*

Buffered bus for marketed** and user built peripherals.

Here is an example of how your Computer Continuum Expansion Board may be implemented:

- Four 44 pin @ .156 in. card connectors. Logic is in same order as on Sinclair's port.



- Circuit cards (Radio Shack TM) for your own circuits or future developments
- Room for wire wrap
- Gold over nickel, plated fingers
- ZX 16K RAM (decoder responds to its presence via $\overline{\text{RAM}}$ $\overline{\text{CS}}$)
- Voltage regulator 5v, 3A, LM323 (optional)
- Board fastens to back of ZX81 (Sinclair provided the holes)
- Way to introduce any on card sourced data bus direction signals.
- Finest quality board: plated thru holes, legend, solder mask, tin plated.
- Available: $33 + (Calif. res. tax $1.95) = BARE BOARD + Connector + shipping + Extensive documentation.

- These two sets of pads are at .1 in. centers, .2 in. between rows. Use them at your convenience for edge connectors or jumper cable headers. 50 pins.
- Straight-forward layout exposes data, address, and control busses.
- 8 chips needed; 5 for buffers, 3 for a decoder to determine the direction of the bi-directional data bus buffer.

1	74LS245
3	81LS95
1	74LS367
1	7400
1	7404
1	7425

- Holes for bypass cap at each chip.
- Pin to disable all buffers. (option to control from bus)
- Connector (supplied) to Sinclair port. Gold tipped, with keyway. With unbent pins the ZX81 can mount vertically on the board uncased.

* ZX80 w/8K ROM will require a resistor and a wire soldered on to control $\overline{\text{ROM}}$ $\overline{\text{CS}}$ as the ZX81 has. The ROM repeats itself. The decoder frees these addresses from the ROM so we can use them for memory mapped I/O.

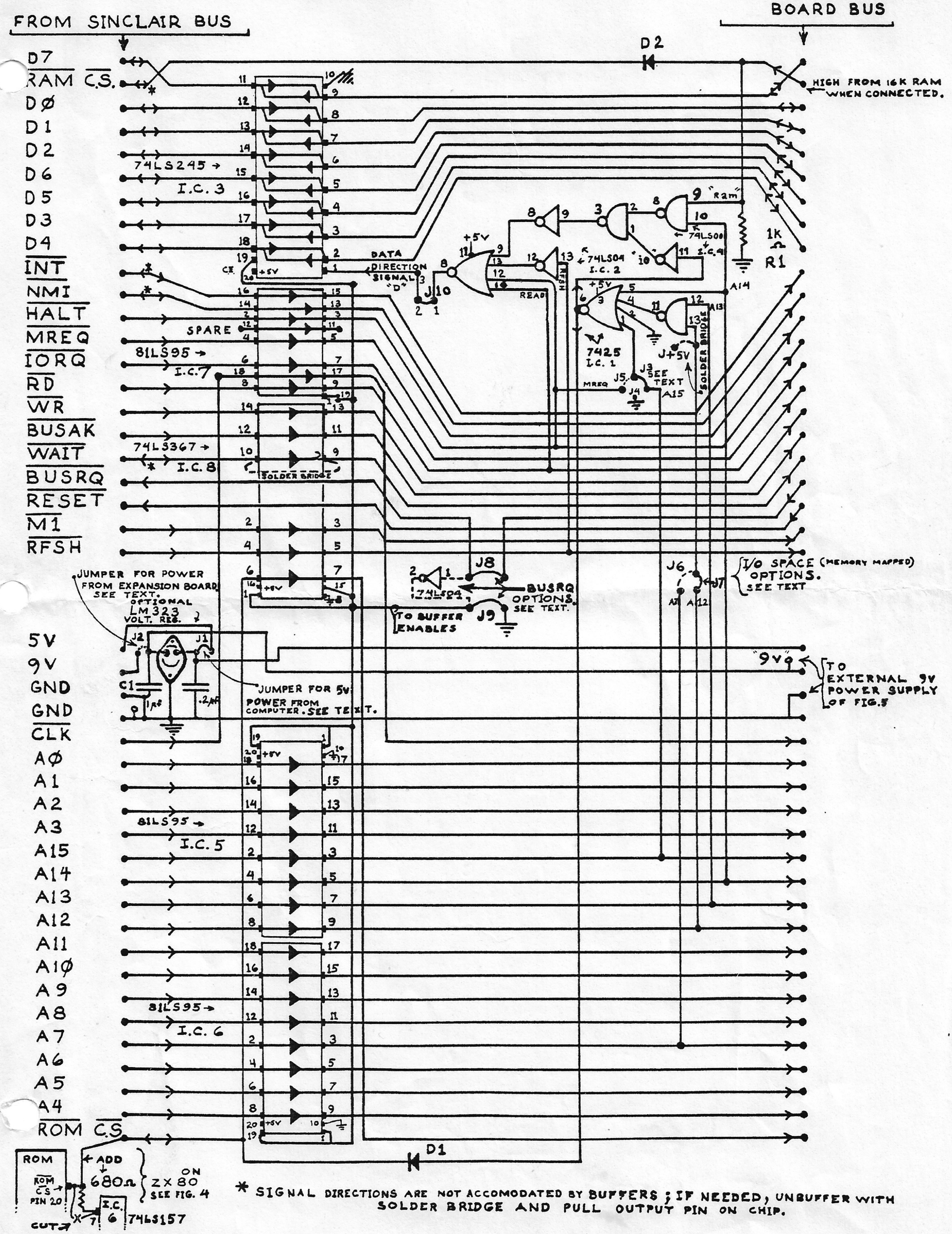
**ZX printer should work on board with a simple decoder on card. Printer unreleased.

- KIT $60. All parts except volt reg. Cal res add $3.80

Computer Continuum

301 16th Avenue, San Francisco CA. 94118 (415) 752 6294
Allow up to 6 weeks to delivery of KIT.

FIG. 1 schematic



* SIGNAL DIRECTIONS ARE NOT ACCOMODATED BY BUFFERS; IF NEEDED, UNBUFFER WITH SOLDER BRIDGE AND PULL OUTPUT PIN ON CHIP.

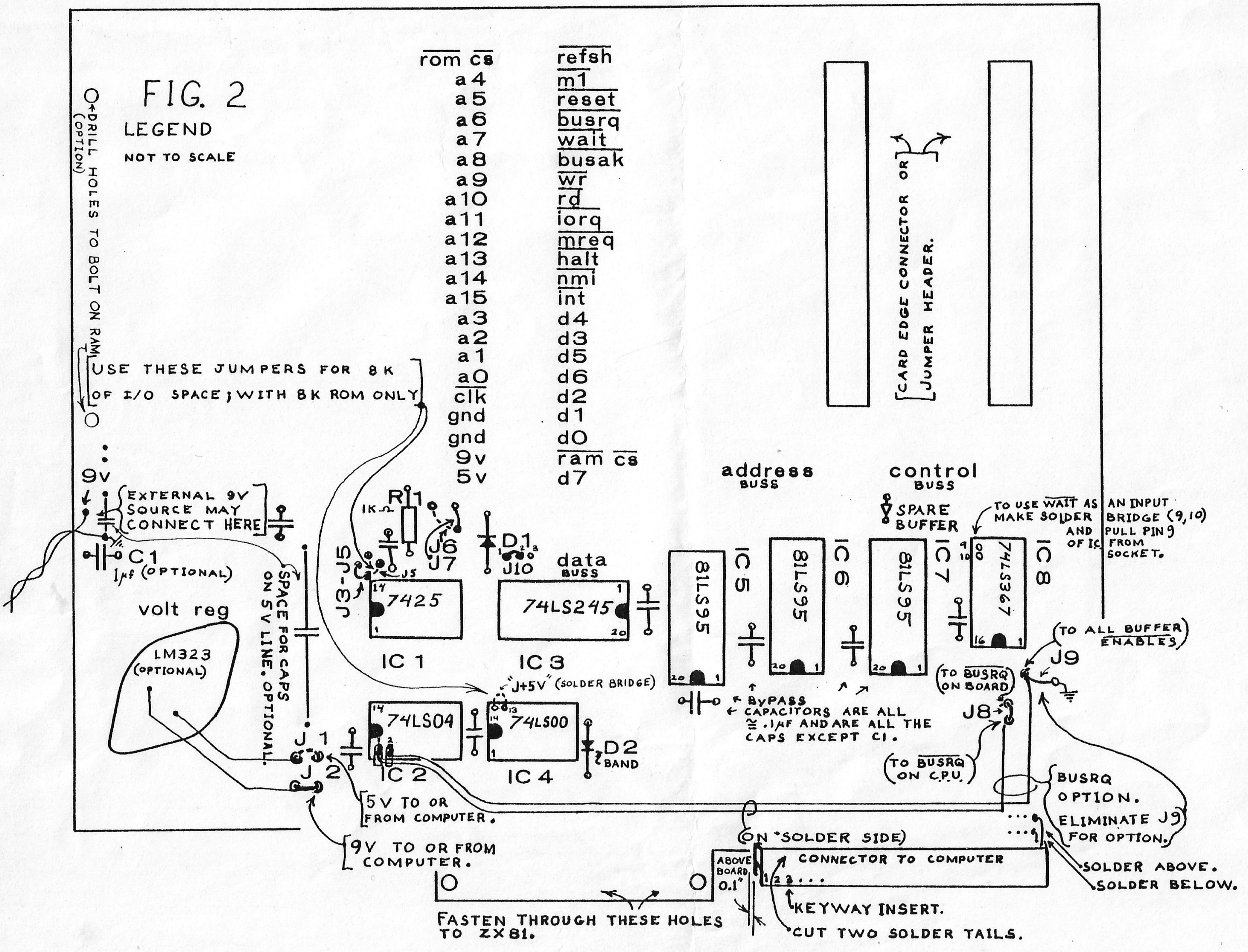
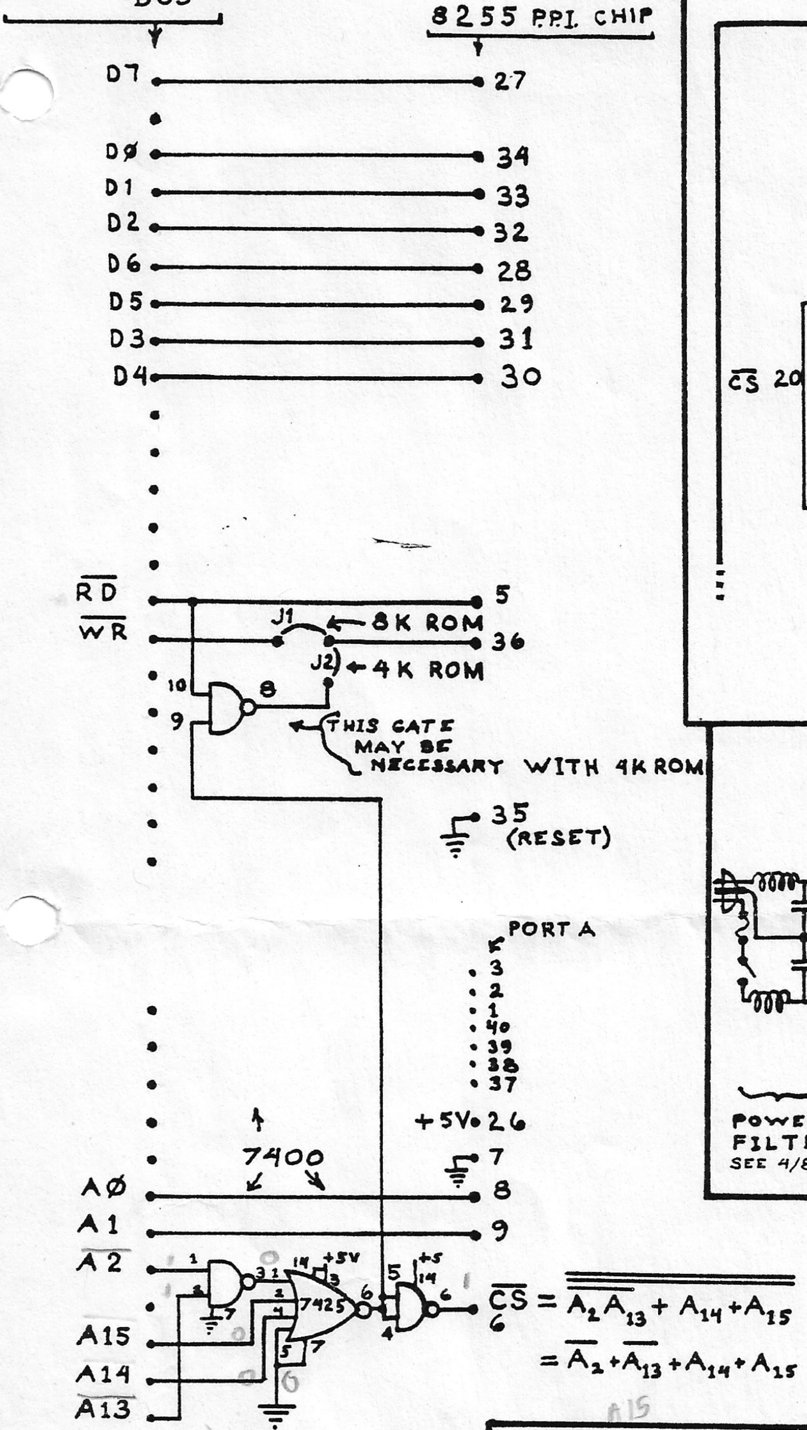


FIG. 2

LEGEND
NOT TO SCALE
DRILL HOLES TO BOLT ON RAM (OPTION)
USE THESE JUMPERS FOR 8K OF I/O SPACE; WITH 8K ROM ONLY
rom cs
a4
a5
a6
a7
a8
a9
a10
a11
a12
a13
a14
a15
a3
a2
a1
a0
clk
gnd
gnd
9v
5v
refsh
m1
reset
busrq
wait
busak
wr
rd
iorq
mreq
halt
nmi
int
d4
d3
d5
d6
d2
d1
d0
ram cs
d7
CARD EDGE CONNECTOR OR JUMPER HEADER.
9v
EXTERNAL 9V SOURCE MAY CONNECT HERE
C1 1μf (OPTIONAL)
volt reg
LM323 (OPTIONAL)
SPACE FOR CAPS ON 5V LINE. OPTIONAL.
J3-J5
J5
1KΩ
R1
J6
J7
D1
J10
data BUSS
7425
IC 1
74LS245
IC 3
"J+5V" (SOLDER BRIDGE)
74LS04
IC 2
74LS00
IC 4
D2
BAND
J1
J2
5V TO OR FROM COMPUTER.
9V TO OR FROM COMPUTER.
address BUSS
81LS95
IC 5
81LS95
IC 6
control BUSS
SPARE BUFFER
81LS95
IC 7
74LS367
IC 8
TO USE WAIT AS AN INPUT MAKE SOLDER BRIDGE (9,10) AND PULL PIN 9 OF IC FROM SOCKET.
BYPASS CAPACITORS ARE ALL ≅ .1μF AND ARE ALL THE CAPS EXCEPT C1.
(TO ALL BUFFER ENABLES)
J9
(TO BUSRQ ON BOARD)
J8
(TO BUSRQ ON C.P.U.)
BUSRQ OPTION.
ELIMINATE J9 FOR OPTION.
SOLDER ABOVE.
SOLDER BELOW.
(ON "SOLDER SIDE)
ABOVE BOARD 0.1"
CONNECTOR TO COMPUTER
1 2 3 . . .
KEYWAY INSERT.
CUT TWO SOLDER TAILS.
FASTEN THROUGH THESE HOLES TO ZX81.

MM/OR I/O

FIG. 3



$$\overline{CS} = \overline{\overline{\overline{A_2}A_{13}} + A_{14} + A_{15}}$$
$$= \overline{A_2} + \overline{A_{13}} + A_{14} + A_{15}$$

ZX80 SOLDER SIDE CIRCUIT MODIFICATION FIG. 4

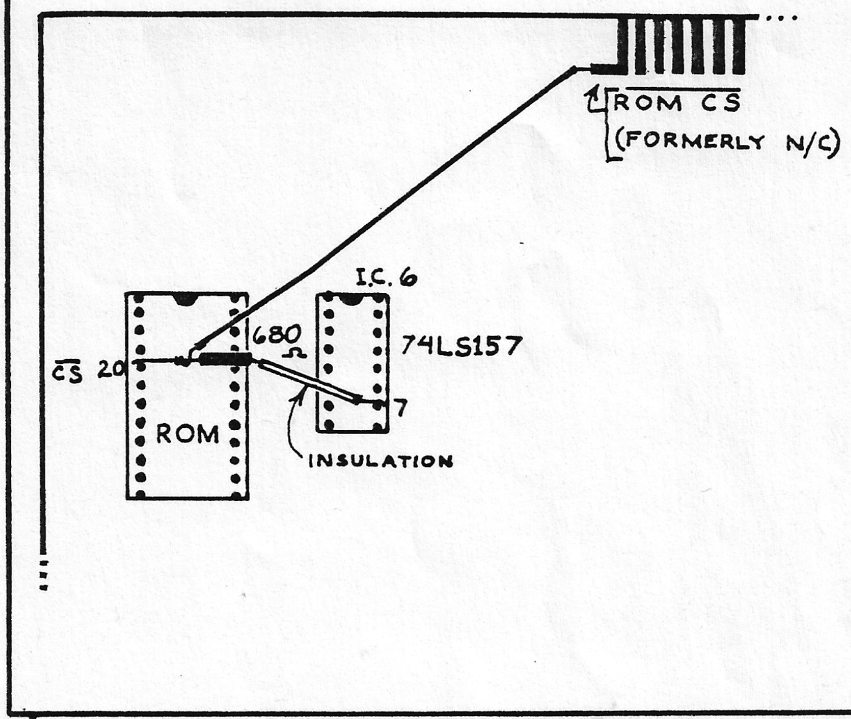
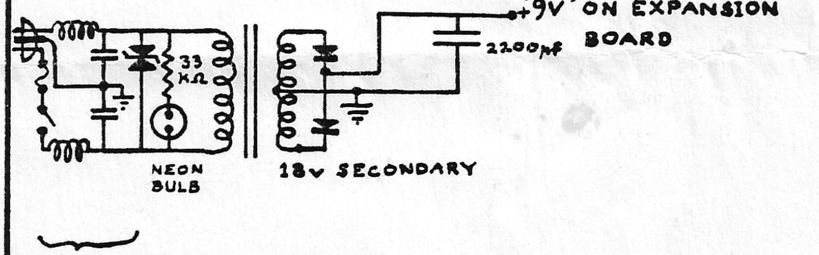


FIG. 5 OFF BOARD POWER SUPPLY



POWER LINE FILTER. OPTIONAL
SEE 4/82 POP. ELECTRONICS.

FIG. 6 ADDRESSING SCHEME

	32,768	16,384	8192	4096	2,048	1,024	512	256	128	64	32	16	8	4	2	1
	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
	A15	A14...		J7					J6					↓		
4K OF I/O (J3, J6) →	0	0	1	0	0	0	0	0	1	0	0	0	0	I/O PORT DECODER	8255 P.P.I. OPERATIONS	
4K OF I/O (J3, J7) →	0	0	1	1	0	0	0	0	0	0	0	0	0			
8K OF I/O (J5, J+5V) →	0	0	1	0	0	0	0	0	0	0	0	0	0			
EXAMPLE: TO POKE DATA INTO CONTROL REGISTER OF 8255 P.P.I., WITH THE JUMPERS AS ON THE LEGEND, USE THIS ADDRESS →	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1

= 8192 + 4096 + 4 + 2 + 1 = 12295

COMPONENT LIST

(a) Integrated circuits.

No.	Type	No. of Pins	Comment	Quantity	Price (Jameco)
I.C.1	7425	14	dual nor	1	$ .34
I.C.2	74LS04	14	hex inverter	1	.35
I.C.3	74LS245	20	octal bus xver	1	2.95
I.C.4	74LS00	14	quad nand	1	.2
I.C.5-7	81LS95	20	octal buffer	3	1.95
I.C.8	74LS367	16	hex buffer	1	.69
	LM323		voltage regulator 5 v, 3 amps (optional)*	1	6.00

(b) Sockets.

Type	No. of Pins	Quantity	Price each	Source
I.C.	14	3	$ .20	Jameco
I.C.	16	1	.22	"
I.C.	20	4	.34	"
card edge	44 @ .156"	4	4.00	Radio Shack
card edge	50 @ .1" (optional)	1	4.00	"
card edge	46 @ .1"	1		provided with Board
keyway insert for above		1		"

(c) Other components.

Description	Quantity	Source	
R1, resistor 1000 ohms 1/4 w. ✓	1	Radio Shack	
D1-D2, diode, switching in 914 or equiv. ✓	1	"	
Capacitors, approx. .1µf 10v disc.	4 (min) 9 (max)	"	
C1, capacitor 1 µf 20v (optional)*	1	"	
Heat sink, TO3 (optional)*. ✓	1	"	$1.35

*Optional parts for 3 amp voltage regulation, on board.

You may use these parts to construct a power supply (off board). See Fig. 5

1) two rectifier diodes 3A, Radio Shack #276-1141 or equivalent, 79¢.
2) capacitor, 2200 µf, 35v, Radio Shack #272-1020 or equiv. $2.49.
3) transformer, 4 amps, 18v center tapped, Radio Shack #273-1514, $10.95.

I mention Radio Shack and Jameco because they are popular and convenient. Many retail electronics stores carry Jim Paks which carry the 81LS95 chip. Some parts may be found at lower prices in ads at the back of Radio-Electronics Magazine: DR Microdevices, Digi-Key, Solid State Sales. I do recommend the plug in boards from Radio Shack at $4-$5: #276-152 to #276-157.

READ ALL MATERIALS BEFORE STARTING CONSTRUCTION

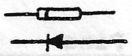
ASSEMBLY INSTRUCTIONS

You will be required to know how to solder, read a schematic and have some familiarity with the nomenclature. If you are new to digital electronics and computers,this is a great place to learn.

Once having obtained the components, the rest is easy. Mount all components on the side of the Board marked "component side," and do all soldering on the side marked "solder side." IMPORTANT! The computer connector has pins soldered from the component side. Raise connector 0.1 in. before soldering; See step 5. J+5v not on circuit board legend.

(1) I.C. sockets.
(Leave the Integrated Circuits off until after the socket is soldered.) Orient markings on socket to match markings on legend. Hold socket flush with Board while soldering.

(2) Diodes. (two)
Observe polarity. Band on diode is bar on diode symbol.



(3) Resistor. Approx. 1000 ohms. brown-black-red.

(4) Capacitors.
Each I.C. is accompanied by a pair of holes for a bypass capacitor. These cut down the noise which can travel over the power supply. Use any disc capacitor within an order of magnitude of .1 microfarads. All of these may not be necessary; I use one on every other chip. If the 9v is supplied via the expansion board, C1 at 1 µf is advised.

(5) Connector to Sinclair Computer (provided with board).
Orient the connector, computer and Expansion Board to each other. Find the two pins that correspond to the keyway and clip their solder tails. Push the keyway insert (provided) into the proper contacts. You must mount the connector approximately 0.1 in. above the surface of the board. You can arrange a perfect fit by assembling the connector, expansio board and computer; then solder the connector in place. You may want to fasten the board to the ZX81 with two 1/4 x 4 screws. The pins leading to the top of the computer are to be soldered from the top (component) side of the Board. Clip excess tail length from connector.

(6) Card Edge Connectors.
Hold connector against Board while soldering. Clip excess lead length. All connectors need not be mounted since holes are plated through. Two connector sites are offered which have holes spaced at .1 in. These are provided because several hardware items have been offered which are designed to plug into the Sinclair computer port. You may use these holes to interface this hardware via jumper cables or card edge connectors. For a jumper header use a type with extra long pins as used for wire wrap and separate the rows another 0.1 inch.
Warning: Keep jumper cables short or properly terminated.

(7) Voltage Regulator. (reg.) Optional
To end all power supply problems, I recommend the LM323 5v 3 amp. I.C. on a large heat sink. Fasten it with both bolts before soldering. The Sinclair 9v pack will provide for the reg. until your circuit cards load it down. Another power supply (transformer, bridge diode and capacitor) may eventually be necessary. See Fig. 5. (A 12v battery can supply the regulator.) The regulator in the Sinclair can power the Expansion Board and 16k ram before overheating.

(8) Jumpers.

J1: For 5v supplied from the computer's regulator to the Expansion Board (without the optional 3A regulator), use J1 and J2. The 16K RAM needs 9v. For 5v supplied from the Expansion Board's regulator to the computer, use J1 (do not use J2) and supply the 9v to the reg at the point on the Board marked 9v.

J2: For power supplied from Sinclair's power pack or any 9v source to the 3A reg and the computer's reg use J2 (do not use J1). Avoid having 2 regulators simultaniously driving the 5v power line.

If you insert the remaining jumpers as indicated on the legend (printed on the circuit board) and schematic (in solid lines), all should be OK no matter which ROM or computer you have.

J3: — Recommended. Connects A15 to decoder. J3 with J6/7 engages 4K of memory mapped I/O addressability when using either 4K or 8K ROMs.

4: Not used.

5: Connects $\overline{MREQ}$ to decoder. J5 with J6 to ground (JGND) engages 8K of memory mapped I/O addressability and only works with the 8K ROM.

J6: — Connects decoder to A7 which implies adding on 2^7 when calculating an I/O address.

J7: — Connects decoder to A12 which implies adding on 2^{12} when calculating an I/O address. (Recommended)

J+5v: (not on legend) Connects decoder input to +5v . Using J+5v works along with J5 to open all 8K of memory mapped I/O addressability. This may not work when using the 4K ROM. J 5v is made with a solder bridge between pins 13 and 14 on I.C. 4. When using this jumper do not use J3, J6, or J7.

J8: — (recommended) Connects $\overline{BUSRQ}$ on Board to $\overline{BUSRQ}$ on Sinclair.

J9: (recommended) Activates the chip select pins of all the buffers. Active low.

J10: Data bus buffer external decoder option.

This buffer is normally writing data outward and must receive a decoder signal for when to switch to read data inward. At J10 are three pads .1 in. apart. Examine them from the solder side to see the circuit. For your first experiments with the Board, make continuity between the first two pads to connect the decoder to the buffer. The decoder provided is only for memory mapped I/O; I left it up to you to configure your own decoder for I/O mapped I/O. This circuit is simple but may take on different forms depending on what you plan to do in I/O space. Simply OR your on-card decoder signal with the board's decoder signal. You may wish to make a connector at J10 as shown in Fig. 9. A simple way to OR the signals is with a resistor and diode as shown in Fig. 10; therefore, only one wire needs to enter from your decoder. Your decoder wire may be placed on the bus if you care to remove one of the control signals which aren't being used on the bus. I used $\overline{INT}$ since the ZX80/1 already uses it for its own purposes. To remove any line, bend out the buffer's output pin on the chip. For the Printer, the decoder would only need to send a high pulse when RD, IORQ, AØ are all low (theoretically); see Fig. 11. When the printer is released in the U.S. you can be sure we at Computer Continuum will make it work on the Expansion Board. If the decoder is any different than what we theorized, we will publish it.

FIG. 9 METHOD 1

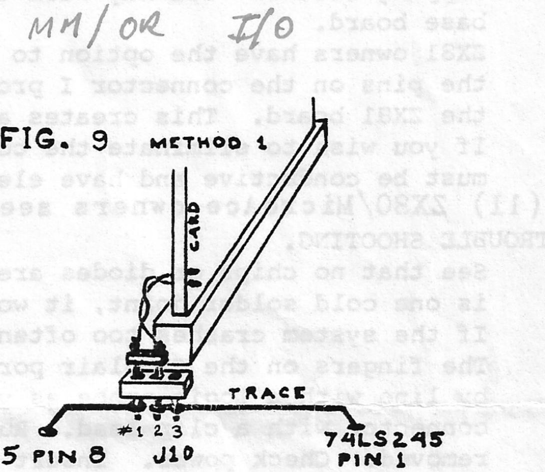


FIG. 10 METHOD 2

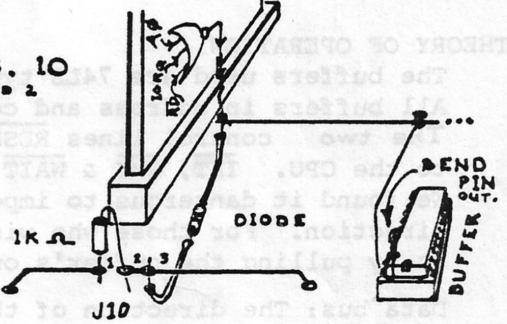
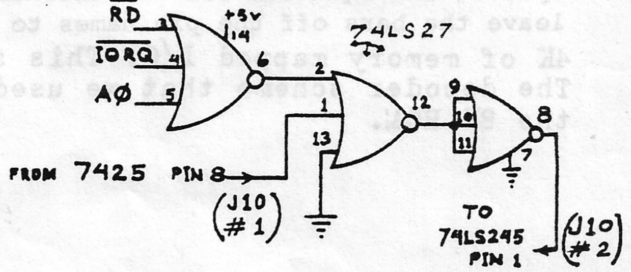


FIG. 11 METHOD 1



(9) BUSRQ (Bus request) option:
(Direct Memory Access).

Some of you will want to develop a D.M.A. card or you may find some reason to stop the computer and put all buffers to their high impedance state. The BUSRQ line on the Expansion Board can be easily arranged to send both the computer and buffers to this dormant state. A spare inverter on I.C. 2 (7404) will be utilized. Prepare 2 wires which will hang on the solder side of the Board from I.C. 2 to J8-J9. Connect pin 1 of I.C. 2 to the buffer enable side of J9 (leave off the J9 jumper to ground). Connect pin 2 of I.C. 2 to J8, including both holes of J8. BUSRQ will remain active low (OV).

(10) Mounting to Computer:

The mounting is up to you but I shall make these suggestions: You will need to raise the computer and Expansion Board approximately 3/8 in. above the table to accommodate the 16K RAM. A simple way to do this is to find 3/8 in. rubber bumpers at the hardware store and glue them to the bottom of the computer and the Expansion Board. Support the center of the Board to insure rigidity. To fasten the Board to the ZX81 use two 1/4 x 4 pan head tapping screws. You may wish to forget the rubber bumpers and bolt everything to a common base board.

ZX81 owners have the option to mount the computer vertically as another card. If you unbend the pins on the connector I provided (or find another connector) the connector will support the ZX81 board. This creates a clean compact package which can be mounted in a metal case. If you wish to eliminate the computer as a source of radio frequency interference, the case must be conductive and have electrical continuity about its seams.

(11) ZX80/MicroAce owners see pg 6.

TROUBLE SHOOTING.

See that no chips or diodes are backwards. Good solder techniques are essential. If there is one cold solder joint, it won't work.

If the system crashes too often or doesn't work, it won't hurt to solder over all the joints. The fingers on the Sinclair port may need cleaning. You may need to check the logic line by line with a logic probe as you alternately apply 'ground' and 'no connection' to the edge connector with a clip lead. Run the computer with the Expansion Board with all chips removed. Check power. Insert buffer chips, then decoder (I.C. 1,2,4) chips and last, the 74LS245; and when the computer stops working, you have a clue. With no cards or memory on the Board, pin 1 of I.C. 3 should be low. If it is pulsing or high, the decoder or signals to it have a problem. Check the CPU bound buffers on the 74LS245.

If power was applied backwards to the chip(s) they may be blown. After inserting the RAM pack see that pin 1 of I.C. 3 is pulsing.

THEORY OF OPERATION.

The buffers used are 74LS type (low power Schottky) and can drive up to 10 LS loads.
All buffers in address and control bus are directing logic away from the CPU.
The two control lines RESET & BUSRQ are left unbuffered and are used purely as inputs to the CPU. INT, NMI & WAIT are CPU inputs but are already used by the ZX80/81 structure. We found it dangerous to impose any data on these lines so we left the buffers in the write direction. For those who wish to impose logic on any of these inputs you may easily unbuffer it by pulling the buffer's output pin and making a solder bridge across the buffer's pads.

Data bus: The direction of the data bus buffer is normally writing outward. The decoder switches the direction inward only when the necessary conditions are met. The decoder can be analyzed in two sections: (1) decoding for RAM read, (2) decoding for memory mapped I/O space read. The reason for this separation (which barred further simplification) is that the signal to the ROM CS had to be sent in response to a read from memory locations in I/O space. The equation for the decoder can be extracted directly from the schematic. I will leave the bars off the pin names to avoid confusion. The following equation opens 4K of memory mapped I/O. This scheme works with both the 4K or 8K ROMs. The decoder scheme that we used for 8K of memory mapped I/O only works with the 8K ROM.

Let: (the signal from the RAM) = Ram,
(the data bus buffer direction signal) = D.

not

$$D = \overline{READ \underset{\text{or}}{+} MREQ + \overline{RFSH} + \overline{\overline{\overline{Ram \underset{\text{and}}{\cdot} A14} \cdot \overline{\overline{(A15+GND+\overline{A12+A13}+A14)}}}}}$$

, which reduces to:

$$D = \overline{READ + MREQ + \overline{RFSH} + \overline{RAM \cdot A14} \cdot (A15+GND+\overline{A12+A13}+A14)} \quad .$$

The above cannot be greatly simplified because the parenthesis must be kept in order to send its result to $\overline{ROM}$ $\overline{CS}$. Let us relabel what is in the above parenthesis = io. "io" is labeled on the schematic. Upon calling I/O space we get io = 0. Therefore:

$$D = \overline{READ + MREQ + \overline{RFSH} + (\overline{Ram \cdot A14 \cdot io})} \quad .$$

When a memory location is read with the RAM pack inserted, we get the following (respective) logic:

$$D = \overline{0+0+\overline{1}+(\overline{1 \cdot 1} \cdot 1)} = \overline{0+0+0+(0 \cdot 1)} = \overline{0+0} = 1.$$

You will find that D = 1 switches the data bus buffer to the read direction. Try calculating some other instances when D = 1.

The use of diodes D1 & D2 is a trick which allows us to impose a + 5v logical 1 upon innocent circuitry while leaving it otherwise unmolested while 0v lurks behind the diode.

It is educational to compare this design to that in "Memory Expansion for ZX80" Jan 82 Byte.

INPUT/OUTPUT PORT:

I suggest using the Intel 8255 Programmable Peripheral Interface because it offers different modes of operation which you program with one POKE command. The schematic is given in Fig. 3. This can fit on about 1/3 of your circuit card leaving ample room for A/D converters or whatever. I suggest wire wrap sockets. I found that when using the MicroAce, an additional NAND gate was required. For machines with 8K ROMs omit the extra NAND gate. Referring to the schematic: use either J1 or J2: J1 should work with 8K machines, and J2 MAY be needed with 4K machines. For other I/O port cards or peripherals you will need to have a different decoder scheme than the one I give in Fig. 3. Try using an address line other than A2 for the port select. Try using $\overline{MREQ}$ instead of A15. A whole set of addresses will call this port as it is not fully decoded.

FIG 7 MICROACE **Solder Side**

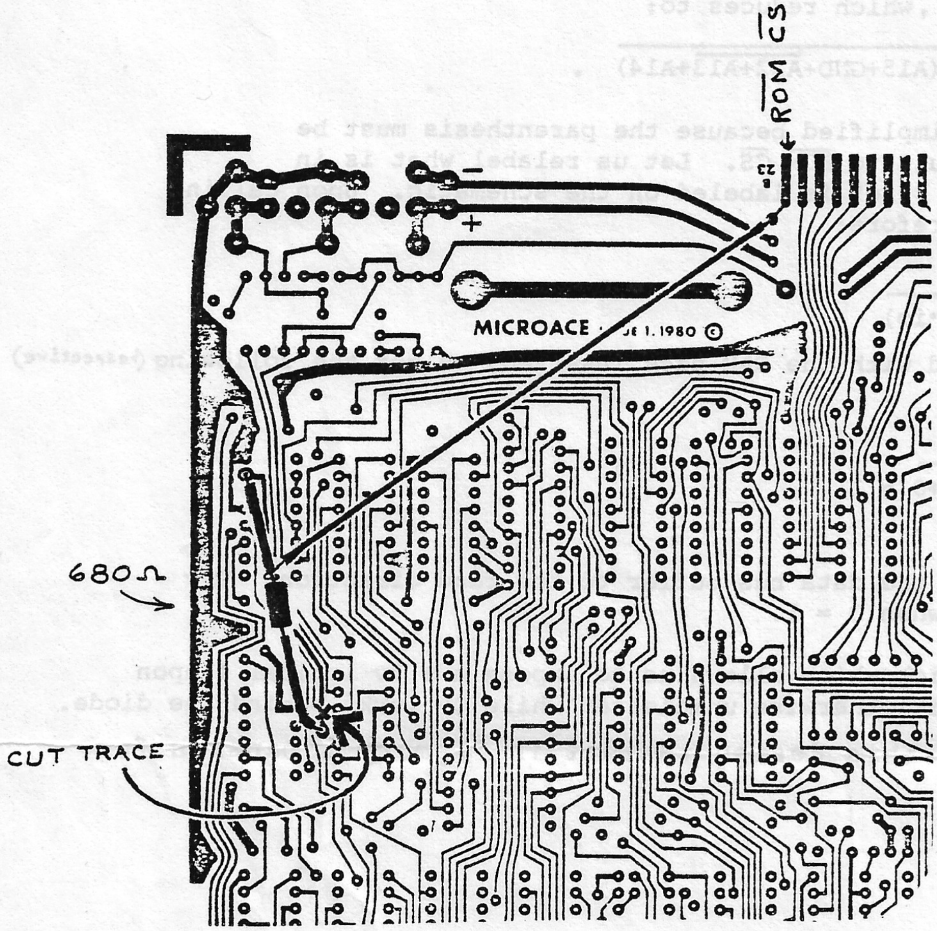
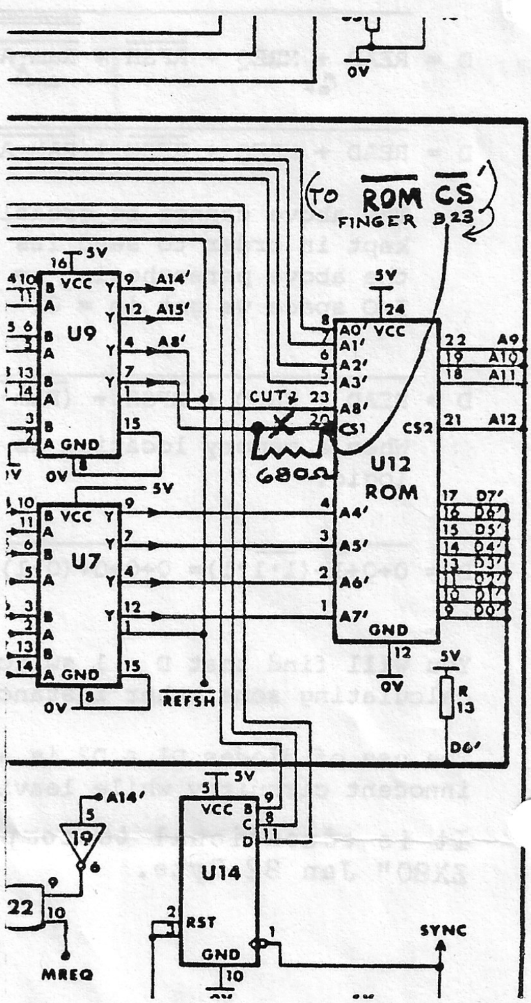


FIG. 8 MICROACE SCHEMATIC

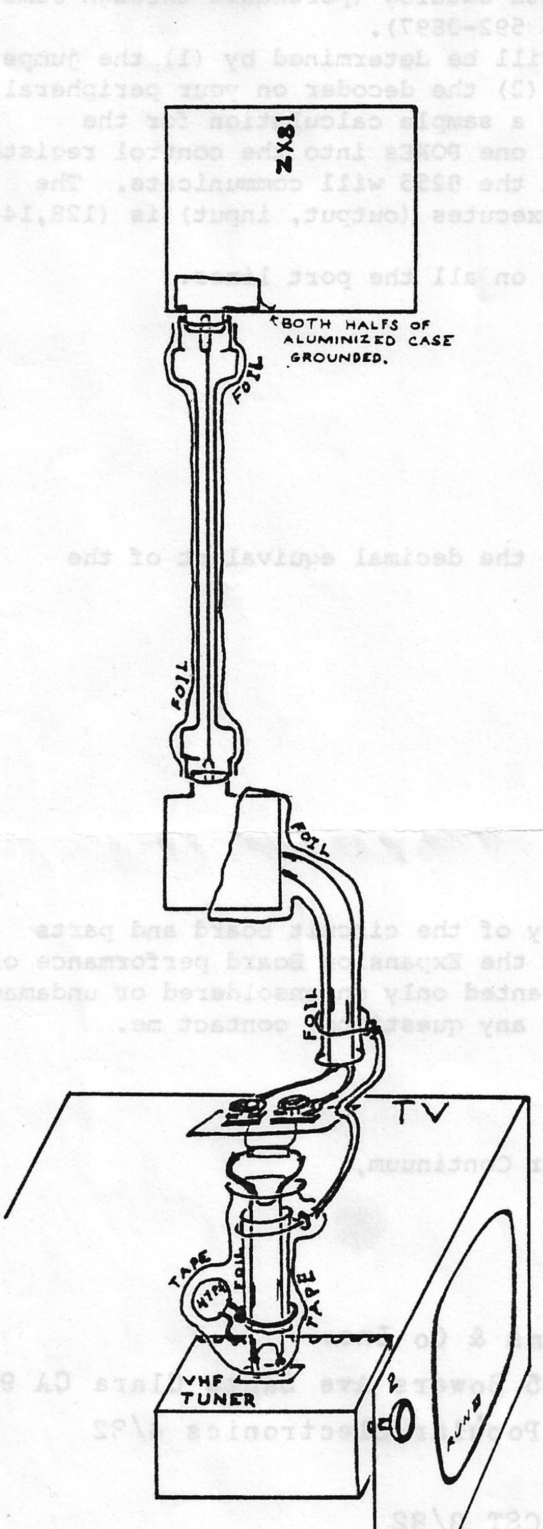


ATTENTION ZX80 (MICROACE) USERS!

A minor circuit modification will be needed on the ZX80 with 8K ROM. See Fig. 4 or (7 & 8). For no apparent purpose the information from the ROM is repeated from addresses 8192 to 16383. The Expansion Board disables the ROM at these addresses so that the addresses can be used as memory mapped Input/Output space. If you add this circuit to the ZX80 it becomes equivalent to what is found in the ZX81. We will insert a resistor in series before the ROM ship-select so that a lead from your Expansion Board (via the edge connector) can connect to the ROM chip-select and override the computer's chip-select signal when needed.

Do all work on the underside (solder side) of the circuit board. Locate pad 20 on the ROM and pad 7 on I.C. 6 (U9) 74LS157; cut the trace which connects these pads. Prepare a miniature 680 ohm resistor with a wire soldered on and some spaghetti insulation as shown in Fig. 4 (7). Solder the other end of the wire to the spare (N/C) finger on the computer's edge connector. Tin resistor and pads before soldering. Solder the leads to the pads. You should not need extra solder. (Thus you only need two hands.) On MicroAce use the pad near the cut trace in Fig. 7 instead of bringing the resistor lead to the ROM pin.

FIG. 12



VIDEO NOTES:

It is unfortunate that Sinclair changed the ZX81 from Channel 32 to Ch 2/3. Everyone has UHF TV. Did the FCC force them to Ch 3? Ch 3 picks up noise originating from the square waves generated in any digital circuitry. The spectral (Fourier) components of the square waves are stronger at Ch 3 (63 mhz) than at Ch 33 (146 mhz). The reason for the aluminized cases in ZX80/1 is to prevent the radiation from the computer from interfering with Ch 2,3,4 TV. Any unshielded peripheral will radiate TV interference. To prevent the Expansion Board from introducing interference on Ch 2/3 ZX81's, there are several methods available: (1) shield the cables between the modulator and TV tuner; (2) shield all digital circuitry; (3)† get a UHF modulator to replace the Ch 2/3 modulator; (4)*convert the TV to a monitor; (5) get a monitor. For those who wish to avoid the inconveniences of methods 2-5 I have furthered method 1. The idea is to isolate the signals between the modulator and the tuner from the rest of the universe. The shielded cable provided with the computer is inadequate. Wrap the cable with aluminum foil and protect it with tape. Open the TV set you plan to use as a monitor, find the wire leading from the antennae connector to the VHF tuner and shield it with foil; connect a wire to it to provide continuit of the shields of the transmission line. At the tuner connect one lead of a 47 picofarad capacitor to the aluminum foil shield and the other lead to the tuner box. The capacitor should couple the high frequencies picked up by the shield to ground. The shield must not touch the TV chassis! TV sets are usually arranged with the chassis connected to one of the wires of the 110 volt plug. Make sure the capacitor lead is the only conductor to the TV chassis. My experiments with several TV sets with the Expansion Board and ZX81 have been satisfactory. If you experience trouble, you may need a metal cabinet for the Expansion Board system, or get a monitor. Try different TV sets also. The Expansion Board is not at fault; Ch 2/3 and digital circuitry don't mix.

Another method of suppressing TV Interference involves canceling out the common mode signals which enter the TV through the antennae leader and the power line. A torroidal ferrite core with the coaxial cable and the TV's power cord wrapped around the core in opposing directions provides the cancelation. See the article in the March, 82 issue of QST :"Doughnuts for the Tennessee Valley Indians"(Toroids for the TeleVision Interference).

If you are already experiencing video problems without the Expansion Board, see that both halfs of the case are grounded and the coils at the 9v and ear/mic are installed to act as low pass filters.

†Quest electronics PO Box 4430C Santa Clara, CA 95054, has a modulator kit for $29.

* V.A.M.P. Inc.,6753 Selma Ave.,Los Angeles. Ca 90028 sells a conversion kit. see 4/82 POP. Electronics.

SOFTWARE

I will introduce some software for an 8255 PPI in the I/O port of Fig. 3 in the Computer Continuum Expansion Board. You will most likely wish to purchase the data sheets on the 8255, found in the eminently useful INTEL Component Data Catalog (purchased through Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002; 415 592-0897).

Referring to Fig. 6, the address of a POKE statement will be determined by (1) the jumper wire scheme you have chosen for your Expansion Board; (2) the decoder on your peripheral card; (3) the address lines on the 8255. Fig. 6 gives a sample calculation for the address of the control register of the 8255. The data one POKEs into the control register determines the mode, direction, and through which port the 8255 will communicate. The control word for all ports in their basic mode which executes (output, input) is (128,144).

Here is a simple test program for outputting 1s and 0s on all the port lines:

```
10 POKE 12295, 128
20 POKE 12292,0
30 PAUSE 30
40 POKE 12291, 255
50 PAUSE 30
60 GOTO 20
```

The following test program will display on the monitor the decimal equivalent of the binary information you place on the port lines:

```
10 POKE 12295, 144
20 PRINT  PEEK  12292
30 SCROLL
40 PAUSE 30
50 GOTO 20
```

LIMITED WARRANTY:

Computer Continuum takes responsibility for the quality of the circuit board and parts delivered to the consumer. We are not responsible for the Expansion Board performance or any damages which may result from its use. Refunds granted only on unsoldered or undamaged merchandise returned within ten days of delivery. For any questions, contact me.

Happy computing

For Computer Continuum,

Eric Reiter

Eric Reiter

References:

Z80 Microcomputer Handbook, W. Barden Jr., Sams & Co Inc.

Intel Component Data Catalog, Intel Corp. 3065 Bowers Ave Santa Clara CA 95051

"Eliminate Data Loss in your TRS80 Computer" Popular Electronics 4/82

"Memory Expansion for ZX-80" Byte 1/82

"Doughnuts For the Tennessee Valley Indians" QST 3/82

Jameco Catalog 1982

Radio Shack Catalog 1982

Dear Chuck

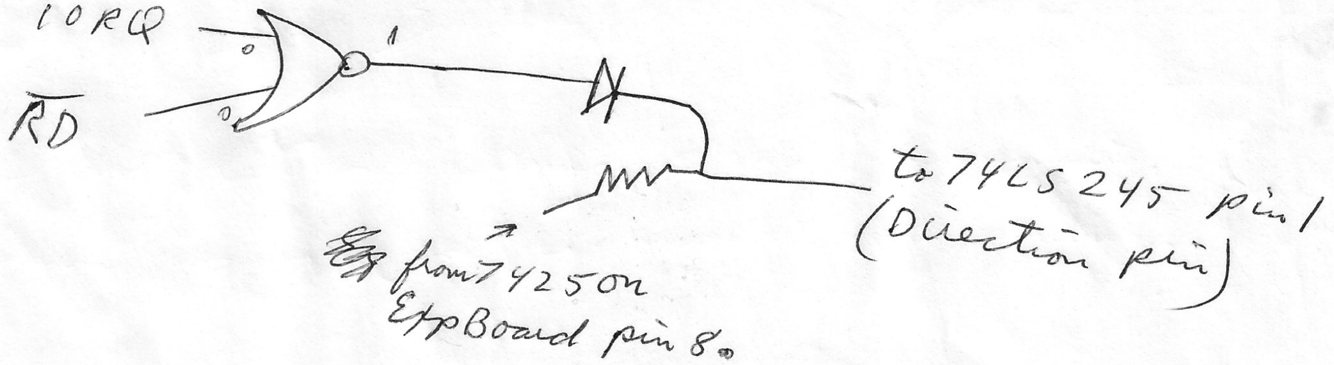
To answer Some of your Questions:

The signal to $\overline{ROM}$ $\overline{CS}$ is necessary to free addresses (8K to 16K) so we can use them for memory mapped Input/Output.

~~The addresses calling~~

The Data from the ROM repeats itself at addresses 8K to 16K and is not necessary.

~~To~~ To get the Expansion board working for I/O mapped peripherals you will need to add the circuit (below). ~~On~~ Build this on a prototyping card.


$\overline{IORQ}$
$\overline{RD}$
0
0
1
to 74LS245 pin 1 (Direction pin)
~~Exp~~ from 7425 on Exp Board pin 8.

This circuit changes the Direction of the Data Buss buffer (TO READ) when any ~~IOR~~ I/O address is asked to be read by the CPU.

The printer hardware is looking for a zero at A2. The printer Hardware Does not sense the other addresses, but the Software Does use the address you sent to me (1 1 1 1 1 0 1 1).

You have the Keyboard address right also accept since there are resistors on the Data bus (inside the ZX81) the external hardware signals ~~input~~ (which may be sent to present) are over-rided by the Keyboard.

Good Luck

Eric Reiter

. . . The "8255" I/O port ~~is~~ (along with the memory) is addressed by the computer as if it was a memory location; therefore it is memory mapped. ~~fig~~ You question referred to fig 3, 9, 10. There is no mention of I/O in these figures. In Fig 6: ("4K of IO" and "8K of IO") refer to memory mapped I/O.

"I/O port decoder" in fig 6 referes to the ~~8255~~ gates immediately preceeding the 8255. There may be flaws in the design of the I/O port ~~that and I would~~ As my ~~maine~~ main concern was the expansion Board. If you can assist in the designs of the port please do so.

Thank you

Eric Reiter